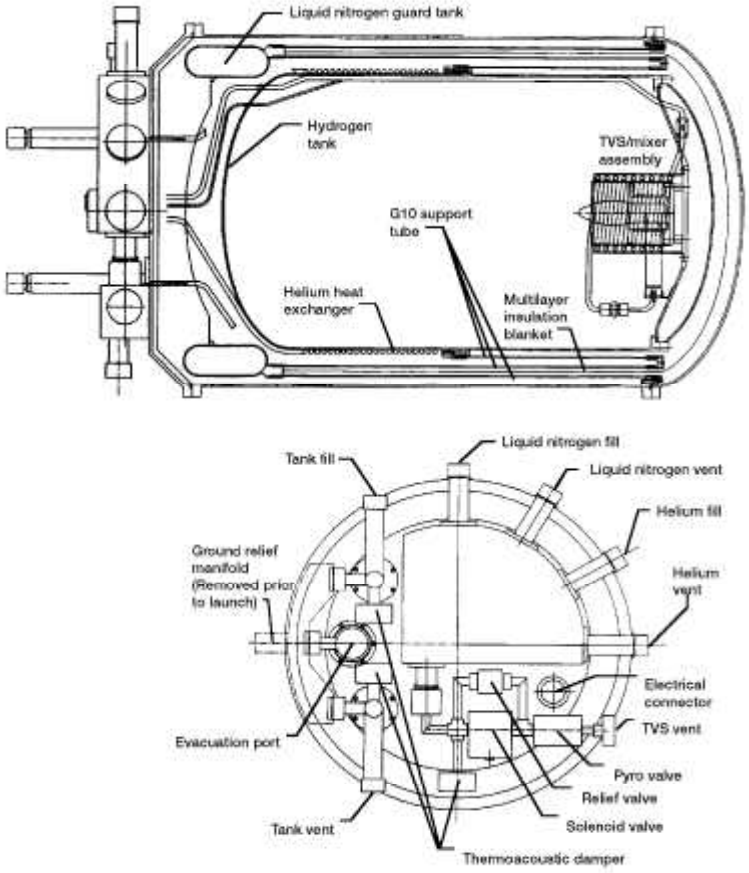
Design Concepts Studied for the Hydrogen On-Orbit Storage and Supply Experiment

The NASA Lewis Research Center, in conjunction with the Utah State University Space Dynamics Laboratory, studied concepts for the Hydrogen On-Orbit Storage and Supply Experiment (HOSS). HOSS is a space flight experiment whose objectives are (1) to show stable gas supply for solar-thermal thruster designs by using both storage and direct-gain approaches and (2) to evaluate and compare the low-gravity performance of active and passive pressure control via a thermodynamic vent system (TVS) suitable for solar-thermal upper stages. This study showed that the necessary experimental equipment for HOSS can be accommodated in a small hydrogen Dewar (36 to 80 liter). Thermal designs can be achieved that meet the on-orbit storage requirements for these Dewars. Furthermore, ground hold insulation concepts are easily achieved that can store liquid hydrogen in these small Dewars for more than 144 hr without venting.



HOSS experiment Dewar layout. Top: Side view. Bottom: Top view.

The drawing shows an 80-liter Dewar design that holds 5.6 kg of hydrogen. The valve panel layout was detailed using off-the-shelf valves like those used on previous flight

programs. The dry weight of this Dewar layout, including valves and plumbing, is estimated at 91.6 kg. The vacuum space is filled with 80 layers of multilayer insulation. Three nested G10 fiberglass[1] tubes greatly increase the length of the tank support, thereby reducing conduction heat transfer. A toroidal liquid nitrogen tank is attached to one end of the tubes. This tank will be filled on the ground to intercept heat and allow the tank to remain filled with hydrogen for long periods of time without venting. A coil of tubing attached to the inner tank allows the liquid hydrogen to be subcooled by liquid helium flowing through these coils. This again extends the ground hold capabilities of the tank and provides a means of quickly reducing tank pressure without venting.

After the 80-liter design was completed, a 36-liter design was made that incorporated the design features of the 80-liter design. The 36-liter Dewar will hold 2.52 kg of hydrogen and weigh 58.6 kg, only 35-percent less than the 80-liter Dewar. One reason that the weights are close is that the valving is identical but the smaller space on the 36-liter Dewar necessitates the use of a stepped lid to achieve the required mounting space. Valve sizes were dictated by commercially available sizes since such valves are difficult to customize.

Now that the HOSS Dewar has been designed, other areas can be detailed. Design studies underway include the selection of suitable low-cost launch vehicles and integration of the Dewar design into a satellite bus. These efforts are bringing the flight of the HOSS experiment inexorably closer.

[1]Fiberglass prepared according to the G10 military standard.

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